



Unveiling Blockchain's Role in Resolving the U.S. Tax Gap Issue

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Date of Submission: 08-10-2023

Date of Acceptance: 22-10-2023

Abstract

The U.S. tax system faces multifaceted challenges stemming from the complexity of tax regulations and the dynamic nature of tax laws, which are subject to frequent updates and significant changes. This complexity contributes to the persistent issue of the tax gap – the disparity between owed taxes and actual payments. Compounding this challenge is the IRS's reliance on legacy IT infrastructure, ill-equipped to manage the evolving demands of modern tax administration. The inefficiencies of this outdated system hinder the IRS's ability to effectively monitor, process and enforce tax compliance.

In this context, this article explores the potential of blockchain technology as a transformative solution to address these challenges. Blockchain's inherent characteristics of transparency, security and immutability hold the promise of significantly reducing the tax gap. By enabling real-time monitoring of transactions and creating reliable audit trails, blockchain can contribute to enhancing voluntary compliance among taxpayers.

Furthermore, the adoption of blockchain technology can empower tax authorities to effectively track, verify and manage tax-related transactions. This includes minimizing underreporting, non-filing and underpayment, thereby improving revenue collection and the overall effectiveness of tax administration.

This article delves into how blockchain technology can revolutionize the U.S. tax system by facilitating seamless transaction reporting, ensuring accurate record-keeping and streamlining communication between taxpayers and tax authorities.

Key words: blockchain, IRS, tax administration, tax compliance, tax gap, tax system.

JEL Classification: K22, O31, O33.

I. Introduction

The Internal Revenue Service (IRS) is a federal agency under the jurisdiction of the United States Department of the Treasury. Its primary

mission is to collect revenue through the administration and enforcement of federal tax laws. The IRS has a significant impact on the lives of the American people, and is responsible for collecting approximately 95% of the revenue to support the operations of the U.S. government (IRS Report to Congress, 2023). The IRS plays a critical role in funding government programs and services, supporting infrastructure, national defense, social welfare and more. It also promotes taxpayer compliance, which is essential for a functioning revenue system. The IRS's enforcement efforts deter tax evasion and fraud, helping to ensure a fair and equitable distribution of the tax burden.

The IRS runs one of the largest and most complex business operations in the world, serving a broad and diverse customer base of millions of individual filers, small businesses, large corporations, tax exempt organizations, and preparers.

The IRS collects and processes personal information on about 290 million individual taxpayers each year (Hatfield, 2018).

During the fiscal year of 2022 the IRS handled over 262.8 million federal tax returns and accompanying documents and collected over \$4.9 trillion in gross taxes. The agency also issued 242.1 million refunds, amounting to more than \$641.7 billion (IRS 2022 Data Book, 2023). This means that about 92% of all tax returns processed by the IRS were eligible for the refund. The average refund claimed on the individual tax return amounted to \$2,153. About 81% of all tax returns were filed electronically, with individual tax returns showcasing an impressive 94% e-file rate in the fiscal year 2022.

The IRS is putting in significant efforts to digitize tax submissions, but there's still a considerable presence of paper forms, including a few that require handwritten signatures (IRS



Inflation Reduction Act Strategic Operating Plan. FY 2023-2031, 2023).

The IRS faces various challenges in the modern era, including adapting to advances in technology, addressing complex global financial transactions, combating evolving forms of tax evasion, managing considerable shortages in professional staff and navigating budget constraints. Additionally, periodic changes to tax laws and regulations necessitate ongoing adjustments to the agency's operations and resources.

The Challenge of the U.S. Tax Gap

In 2022 the Congress passed the Inflation Reduction Act (IRA) of 2022 which appropriates nearly \$80 billion in additional IRS funding, including \$45.6 billion for enforcement, \$25.3 billion for operations support, \$4.8 billion for business systems modernization and \$3.2 billion for taxpayer services.

Table 1. IRA allocation financial summary – FY 2022-2031 (\$ billion)

Transformation objective	Appropriations account (\$ billion), rounded					Total proposed investment
	Taxpayer services	Enforcement	Operations support	Business systems modernization	Clean energy	
1. Dramatically improve services to help taxpayers meet their obligations and receive the tax incentives for which they are eligible	1.5	0.1	2.1	0.7	0.0	4.3
2. Quickly resolve taxpayer issues when they arise	0.1	1.8	0.7	0.6	0.0	3.2
3. Focus expanded enforcement on taxpayers with complex tax filings and high-dollar noncompliance to address the tax gap	0.2	41.7	5.5	0.0	0.0	47.4
4. Deliver cutting-edge technology, data, and analytics to operate more effectively	0.0	0.1	9.2	3.1	0.0	12.4
5. Attract, retain, and empower a highly skilled, diverse workforce and develop a culture that is better equipped to deliver results for taxpayers	0.2	0.7	6.9	0.4	0.0	8.2
Energy security	1.2	1.3	0.9	0.0	0.5	3.9
Total IRA allocations	3.2	45.6	25.3	4.8	0.5	79.4

Source: IRS IRA Strategic Operation Plan. Pub. 3744 (4-2023)

Approximately 60% of the funds are allocated towards the objective of addressing the tax gap, which amounts to \$47.4 billion out of the total \$79.4 billion.

The tax gap represents the disparity between the amount of taxes owed to the government and the amount of taxes actually collected. The IRS periodically estimates the tax gap to gauge historical overall compliance of all types of taxpayers with their federal tax obligations.

There are two concepts of measuring the tax gap:

1. Dollar measures - gross tax gap/net tax gap/tax gap components;

2. Ratio measures - voluntary compliance rate (VCR)/net compliance rate (NCR)/net misreported percentage (NMP)/voluntary reporting rate (VRR).

The gross tax gap is defined as the dollar amount of so-called "true" tax that is not paid on time. The most recent tax gap study released by the IRS in October 2022 covered tax years 2014 through 2016 (Federal Tax Compliance Research: The Tax Gap estimates for tax years 2014-2016, 2022).

Tax gap estimates are most accurate when based on actual taxpayer compliance data for the years being estimated. There is an inherent lag time between the years analyzed and the year the tax gap estimates are



released by the IRS's Research, Applied Analytics and Statistics Division (RAAS), because it takes several years to conduct audits, collect payments, close cases and then analyze the results.

The latest assessment reveals the gross tax gap of \$496 billion, indicating an increase of more than \$58 billion compared to the previous estimate. Following the collection of an extra \$68 billion from late payments (paid both through enforcement and voluntarily), the IRS assessed the net tax gap at \$428 billion.

There are two crucial metrics that gauge the level of compliance with tax obligations – the voluntary compliance rate (VCR) and the Net Compliance Rate (NCR).

The VCR is a percentage calculated by dividing the amount of tax paid voluntarily and on time by the total true tax. The VCR for the tax years 2014-2016 is 85.0%.

The NCR represents a percentage obtained by dividing the total of all timely, enforced and voluntary late payments by the total true tax. The 2014-2016 NCR is estimated at 87.0%.

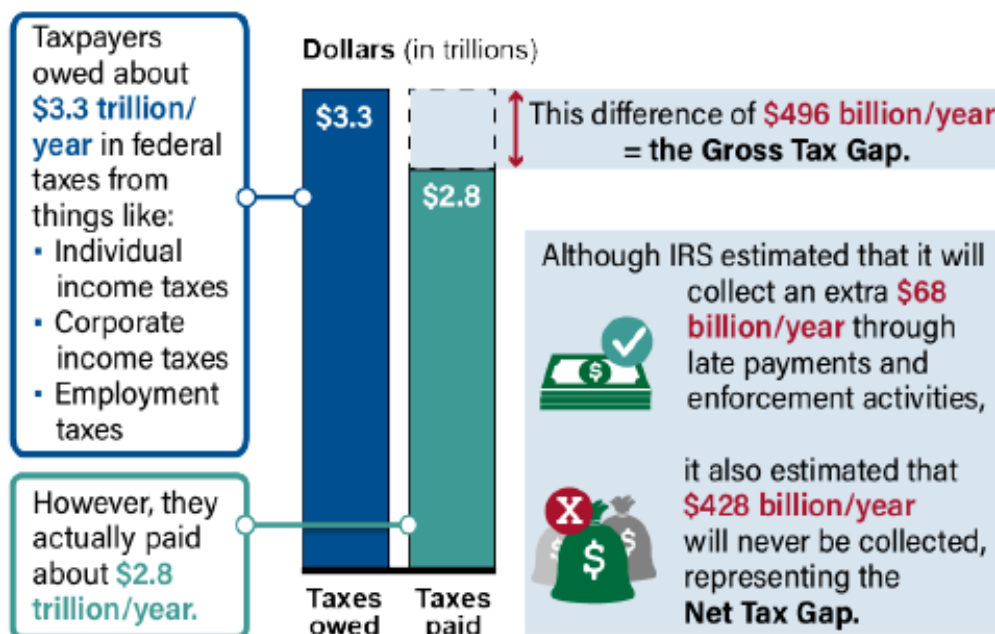


Figure 1: IRS's annual average tax gap estimate for tax years 2014-2016

Source: IRS | U.S. Government Accountability Office (GAO-23-106448). February 2023

The gross tax gap comprises three main components:

- Underreporting (tax understated on timely filed returns, \$398 billion)
- Non-filing (tax not paid on time by those who do not file on time, \$39 billion)
- Underpayment (tax that was reported on time, but not paid on time, \$59 billion).

The underreporting represents the amount of taxes that taxpayers fail to accurately report on their filed returns within the stipulated time frame (~80% of the total gross tax gap). In contrast, the non-filing accounts for the taxes that taxpayers owe but neglect to report because they do not file a mandated return on time. Lastly, the underpayment represents the amount of taxes that remain unpaid despite being duly reported on returns submitted within the designated timeframe.

The components of the gross tax gap can be visually presented in the following way:

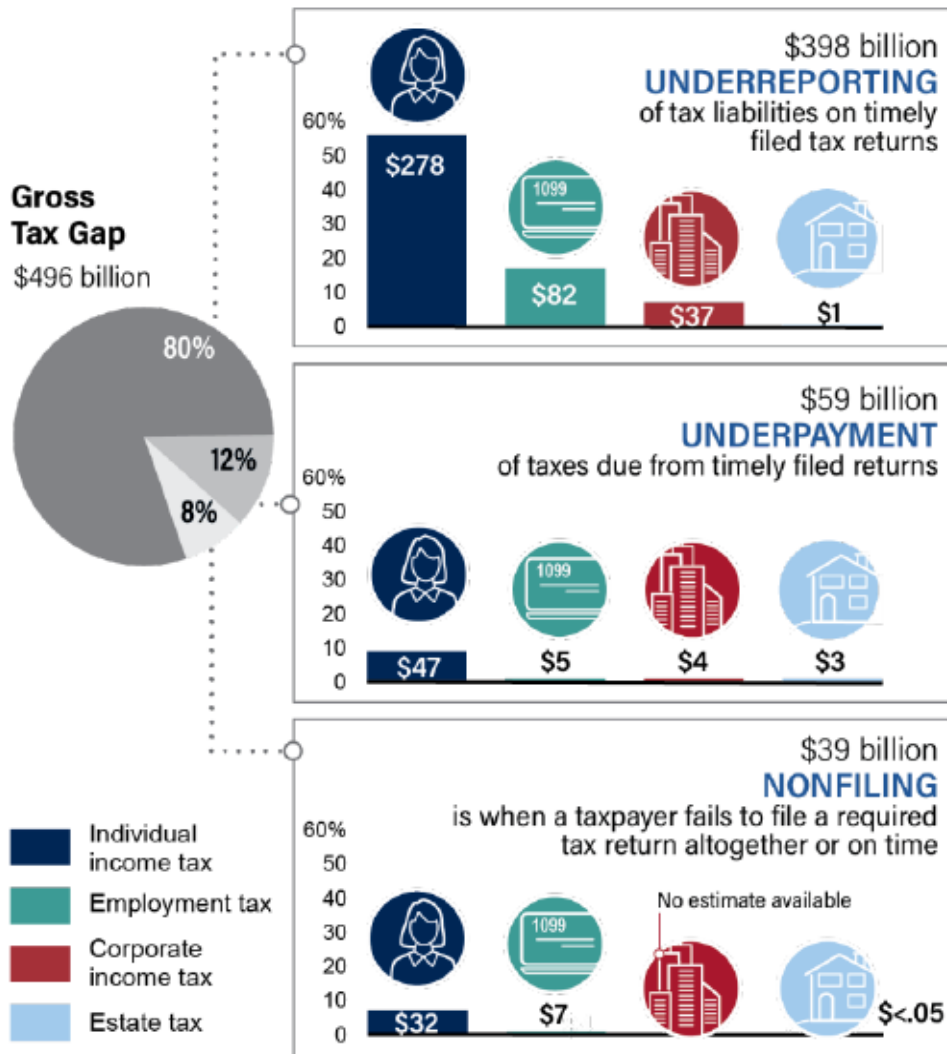


Figure 2: Estimated average annual gross tax gap by type of noncompliance and tax (tax years 2014-2016)
 GAO analysis of the IRS data | GAO-23-106448. February 2023

It is worth noting that IRS estimates do not include underreporting attributable to income from illegal sources, despite the existing requirement to report income from both legal and illegal sources. The IRS also excludes from the tax gap calculation a substantial portion of underreporting associated with passthrough entities and offshore investments.

In an effort to provide more frequent and timely updates, RAAS is actively developing methods to “forecast” the Tax Gap in advance of actually reporting compliance data. Then the estimates are revised when the actual data are later collected and analyzed (Rettig, 2021).

The tax gap estimate released in October 2022 also includes projections for tax years 2017-2019. The projected annual gross tax gap for the tax years 2017-2019 timeframe is \$540 billion (plus

\$33 billion, or 9% compared to the latest gross tax gap estimate for the tax years 2014-2016). The projected Voluntary Compliance Rate (VCR) is 85.1%. It is anticipated that approximately \$70 billion of the gross tax gap will eventually be paid, leading to an annual net tax gap of \$470 billion (plus \$42 billion, or 10% compared to the latest net tax gap estimate for the tax years 2014-2016). The NCR projection is 87.0%.

The U.S. Treasury Department projections made in May 2021 assessed the gross tax gap for 2019 tax year at \$630 billion (after “adjusting the tax gap for passthrough and offshore evasion”) (The American Families Plan Tax Compliance Agenda, 2021).

The estimated net compliance rate (NCR) for 2014-2016 as well as projected NCR for 2017-



2019 remains steady at 87%. This implies that despite the IRS's extensive endeavors to collect payments, including conducting tax audits, filing tax liens, issuing levies and establishing payment arrangements of all kinds, a significant 13% of total "true" tax obligations remain outstanding and unpaid.

In recent years there have been various legislative initiatives proposed and bills issued with the primary aim of closing the tax gap. However, such a broad aim formulation is widely criticized by the professional community of legal and tax experts which commonly sustain the position that the tax gap should not be a performance target.

The paper titled "Tax Gap's Many Shades of Gray" by D.J. Hemel et al. (2021) warns that "setting such a goal for the IRS would produce potentially perverse incentives. For example, one easy way for the IRS to reduce the measured tax gap would be to instruct examiners not to challenge aggressive reporting positions adopted by sophisticated taxpayers who exploit legal gray areas. The IRS would thereby reduce the amount of "true tax" owed—and thus the gap between "true tax" and the amount actually paid. However, such measures would be at odds with the goals of raising revenue and allocating tax burdens equitably" (Hemel et al., 2021).

Instead issues with underreporting and non-filing can be addressed through improving taxpayers' experience by more effectively navigating them through the intricacies of the comprehensive U.S. tax system. It is important to recognize that underreporting as well as non-filing do not necessarily imply tax evasion; they can arise from a variety of other causes, such as misunderstanding the tax laws and application of some ambiguous tax rules for the taxpayers' advantage as recommended by tax professionals and lawyers.

The U.S. tax system is based on the fundamental principle of voluntary compliance which basically means "IRS's reliance (read dependence) on taxpayers to assess the correct amount of tax on their tax return, file those returns properly and timely pay the tax due" (Manhire, 2015). However, U.S. tax laws are excessively complex, and here is where this complexity becomes a real problem "because complex rules lead to confusion, errors and (finally) distrust, which reduces self-assessment and voluntary compliance" (Collins, 2022).

The Internal Revenue Code (IRC) contains 9,834 code sections – many containing detailed subsections – and a six-volume set of corresponding

regulations. An individual taxpayer is estimated to spend 13 hours and \$240 out-of-pocket costs just to prepare and file one annual tax return. For a small business, the amount of time and money spent on tax compliance is roughly 82 hours and \$2,900. Individual taxpayers spent a total of 897 million hours in 2022 just on recordkeeping. This is in addition to the 1.15 billion hours spent on tax preparation of individual returns. Business entities spent about 1.14 billion hours and \$48.3 billion on tax preparation in 2022.

The complexity of the national tax system is not only a major obstacle to taxpayers' voluntary compliance but also gives rise to significant strategic and operational challenges for the IRS itself. Probably, one of the most critical issues the IRS is currently facing is the absence of adequate IT infrastructure comprehensive enough to serve the needs of all stakeholders.

IRS history of technological advancements and failures

The IRS's historical trajectory towards computerization commenced at the conclusion of World War II. The tax landscape that had demanded a modest 3.5 million individual returns in 1917 underwent a transformative expansion due to World War II funding, extending its purview to encompass 42.6 million taxpayers. The complexities arising from overseeing this nearly 43 million taxpayers impelled the IRS to embark upon automation experiments in 1948. A decade later the IRS introduced the ADP - Automated Data Processing. This strategic blueprint involved regional centers capturing tax data on magnetic tape, subsequently dispatched on a weekly basis to a "National Computer Center" situated in Martinsburg, West Virginia. This center was designed to house mainframes, each equipped with a comprehensive master file on every taxpayer—the "IMF system".

In 1962 ADP was able to process up to 680,000 characters per second (IRS History Timeline, 2019), and by 1967 it was fully implemented—ensuring every tax return was seamlessly processed through ADP, and the National Computer Center meticulously maintained taxpayer master files. This heralded an era of heightened IRS endeavors, encompassing transcription of data directly onto tape using keyboards, algorithmic identification of error-prone returns, computational strategies to enhance compliance and revenue collection, innovation in magnetic tape-based form submissions, automated deposit and payment systems and even experimentation with microcomputers for preparing



taxpayer returns. The IRS's success in using computers became a model that private companies wanted to follow. This made other countries interested in getting advice from the IRS when they wanted to computerize their own systems.

Motivated by its initial successes in computerization, the IRS made a strategic decision to significantly upgrade its system in 1975. Shortly after that, a new modernization plan - the Tax Administration System (TAS) - was presented. This plan was aimed at minimizing errors, raising the effectiveness of tax audits and significantly automating applications used by taxpayers and agents alike. However, this plan became widely criticized by some politicians who saw in it a significant danger to taxpayers' sensitive data collected and held by the IRS. Finally, it was decided to simply replace outdated equipment without performing any major system's restructuring and upgrade.

Then came 1985, subsequently earning a reputation as the worst tax season in the entire history of the IRS. The major tax laws updates together with numerous computer failures which were not upgraded in time due to insufficient funding, literally resulted in reputational, technological and political catastrophe. In some states taxpayers had to wait for 12-16 weeks to receive their refunds, which was the longest wait time in the preceding five years.

In 1988 the IRS announced its Tax System Modernization plan (TSM) aimed at replacement of its 25-years old IMF system with the innovative network. Approximately \$4 billion was invested by the IRS in their efforts to achieve this objective. Unfortunately, the systems the IRS developed failed when it came to its implementation in practice. As a result, Congress cut funding for TSM, and the President appointed an IRS commissioner with a high-tech business background. "The IRS has spent \$4 billion with nothing to show for it," said Rep. Jim Ross Lightfoot (R-Iowa), chairman of the House Appropriations subcommittee that controls the IRS budget. Even in the late 1990s the IRS system continued to depend on "a series of very large tape files" (Rossotti, 1999). Dealing with taxpayers' information still involved a lot of manual effort and was extremely time-consuming: once a week the data was reloaded at the National Computing Center, and this process took approximately three days.

In 1997, the IRS introduced a \$7 billion initiative, Business Systems Modernization (BSM), led by the new commissioner. BSM aimed to replace the outdated 35-year-old magnetic tape

system at the National Computing Center with the modern Customer Account Data Engine (CADE) database. This marked the third major attempt in two decades to update the center. Unlike previous efforts, the new plan sought expertise from external tech specialists. However, a blend of mismanagement within the IRS and the tech experts' failure to grasp IRS processes led to delays and budget overruns. The Government Accountability Office concluded that BSM's ambition surpassed the IRS's capabilities. And, finally, in 2008 the new IRS commissioner significantly shrank BSM's scope, limiting it to the one single goal - to fully implement CADE.

"While some progress had been made with CADE, the 1960s IMF system at the National Computing Center remained the center of IRS computing, decades after other organizations had begun using modern databases" (Hatfield, 2018). But even CADE was not implemented in its full scope despite a significant budget associated with it. Though certain advancements materialized, such as the transition to daily processing and posting of select data instead of a weekly schedule, the initiative remained plagued by setbacks and financial overruns. The culmination of these challenges resulted in a state where, by 2016 the complete integration of CADE had not been achieved, causing a deceleration in the drive to significantly innovate the IMF system.

Because of a shortage of allocated financial resources and a multitude of pressing goals, the IRS couldn't prioritize the implementation of CADE. There were multiple projects underway, including transition to electronic tax forms in lieu of paper-based returns, promoting e-filing, adjusting system's algorithms for the ACA (Affordable Care Act) and enforcing FATCA (Foreign Account Tax Compliance Act) among others. The lack of clear focus led to the failure of even basic IT maintenance goals. For instance, during 2011-2015, the IRS allocated \$139 million for a basic Windows update - but it was unsuccessful.

"While the history of technology modernization at the IRS does not inspire confidence for its future, there have been some successes. Indeed, until the 2015 cyberattacks, the public-facing technology used by the IRS was largely a success story" (Hatfield, 2018). Presently, electronic filing encompasses more than 213 million tax returns, constituting a significant 81% of the total filed returns. This notable shift can be attributed to the enactment of the Internal Revenue Service Restructuring and Reform Act of 1998 (RRA). The IRS Restructuring and Reform Act of



1998 prompted the most comprehensive reorganization and modernization of the IRS in nearly half a century (IRS History Timeline, 2019). This legislation compelled the IRS to develop means for taxpayers to access their accounts online and submit tax returns electronically. Furthermore, it introduced a distinct financial mechanism to facilitate these initiatives and assigned the responsibility of annually assessing the IRS's advancements to the Treasury Inspector General for Tax Administration. The introduction of the RRA effectively compelled the IRS to allocate higher importance to technology serving the public sphere. This legislative shift was influenced by a comprehensible political rationale, being a response to a surge of grievances concerning challenges encountered while interacting with the IRS. In practical terms, the most noteworthy advancements in IRS IT have come from Congress-mandated electronic filing. However, this decision by Congress also resulted in a reduced emphasis on the technology employed by the IRS for processing returns, accepting payments and issuing refunds.

“Public-facing programs like electronic filing have been something of a facade, obscuring the greater technological needs of the IRS. But the facade is no longer obscuring these needs. It is the electronic filing program that enables the filing of fraudulent returns with payments made to criminals’ bank accounts. And it was the Get Transcript program that enabled criminals to steal personal information to sell, to use in other crimes, and to file even “better” fraudulent returns in the future” (Hatfield, 2018).

In 2019 the IRS released Integrated Modernization Plan - a six-year road map for achieving modernization of IRS systems and taxpayer services in two three-year phases, based on four pillars:

- 1) Taxpayer Experience,
- 2) Core Taxpayer Services & Enforcement,
- 3) Modernized IRS Operations, and
- 4) Cybersecurity & Data Protection.

Taxpayer experience: The IRS would deploy a range of new and enhanced technology solutions to help taxpayers understand the law and resolve issues quickly and efficiently. Advanced programming would empower taxpayers with information about their account, tax obligations and payment options while protecting taxpayer information and data.

Core Taxpayer Services and Enforcement: The IRS would continue to evolve core tax systems to provide quicker and easier tax filing services by integrating tax processing systems that increase cost

effectiveness, enable real-time processing of returns and deploy data analytics to combat fraud.

Modernized IRS Operations: The IRS would improve operational efficiencies by reducing system complexities, which will accelerate the pace of change and the adoption of emerging technologies to reduce costs and manual effort. This approach included procuring software that would be capable of completing laborious tasks in seconds through automation and artificial intelligence, eliminating error-prone manual work and increasing speed and accuracy.

Cybersecurity and Data Protection: The plan introduced unparalleled data and refund fraud protections, protecting against approximately 1.4 billion cyberattacks annually and proactively responding and anticipating the changing threat environment.

By executing the strategies in the Business Plan, the IRS aimed to help taxpayers “to meet their tax obligations, increase voluntary compliance and decrease the gross tax gap while stabilizing information technology costs over time” (IRS Integrated Modernization Business Plan, 2019).

As highlighted by the IRS Chief Information Officer (CIO) S.G. Garza in the document's opening statement, "It's becoming progressively challenging to fulfill taxpayer expectations and effectively achieve our expanding mission without substantial overhauls to our fundamental tax systems. Our existing computing infrastructure lags behind the demand for immediate data access, real-time engagements and customer-centric services. Additionally, the expenses tied to operating our present technological framework persistently rise. The successful modernization of our information technology bedrock holds paramount importance, as it underpins our capacity to uphold the IRS mission in an economically efficient manner" (IRS Integrated Modernization Business Plan, 2019).

It was declared that the Plan's key targets were fully aligned with the strategic objectives set in the IRS Strategic Plan 2018-2022:





- Empower and enable taxpayers to meet they tax obligations;
- Protect the integrity of the tax system by encouraging compliance through administering and enforcing the tax code;
- Collaborate with external partners proactively to improve tax administration;
- Cultivate a well-equipped, diverse, flexible and engaged workforce;



- Advance data access, usability and analytics to inform decision-making and improve operational outcomes;
- Drive increased agility, efficiency, effectiveness and security in IRS operations.

The summary of the IRS Integrated Modernization Plan proposed in 2019 is presented in Table 2.

Table 2: Modernization Portfolio and Pillars

MODERNIZATION PILLAR	KEY OBJECTIVES	KEY PROGRAMS & INITIATIVES
 Taxpayer Experience: Deliver a service experience comparable to private industry	<ul style="list-style-type: none"> • Help taxpayers resolve issues quickly and efficiently • Empower taxpayers with information about their account, obligations, and payment options • Make services available to customers when they need them • Protect taxpayer information and data 	<ul style="list-style-type: none"> • WebApps (Web Applications) • Taxpayer Digital Communications Outbound Notifications (TDC—ON) • Live Assistance (Callback & Omnichannel)
 Core Taxpayer Services & Enforcement: Streamline and integrate IT programs that enable top-quality service	<ul style="list-style-type: none"> • Integrate tax processing systems to increase the cost effectiveness of operations • Enable real-time processing and increase transparency of returns status • Increase data usability and the use of data analytics to combat fraud 	<ul style="list-style-type: none"> • Customer Account Data Engine (CADE) 2 Transition State 2 (TS2) • CADE 2 Target State • Enterprise Case Management (ECM) • Enterprise Case Selection (if necessary) • Return Review Program (RRP) • Real-Time Tax Processing (RTTP) • Information Returns Processing
 Modernized IRS Operations: Retire and decommission legacy systems in place of more sustainable infrastructure	<ul style="list-style-type: none"> • Reduce complexity of the technical environment • Leverage data to deliver secure, agile, and efficient applications and services • Strengthen organizational agility through automation and streamlining processes 	<ul style="list-style-type: none"> • Application Programming Interface (API) Management • Cloud Execution • Data Digitization • Next Generation Infrastructure • Robotics Process Automation (RPA) • Universal Data Hub / Analytics Tools / Platform • Virtual Desktop
 Cybersecurity & Data Protection: Continue to protect taxpayer data and address emerging threats	<ul style="list-style-type: none"> • Establish trusted and streamlined access to information through identity and access management technologies • Proactively identify emerging threats and vulnerabilities through the use of real-time intelligence information and analytics • Protect taxpayer data and systems via end-to-end visibility and common platforms 	<ul style="list-style-type: none"> • Identity & Access Management (IAM) • Security Operations & Management • Vulnerability & Threat Management

Source: IRS Integrated Modernization Business Plan (2019)

On August 2, 2023 Treasury Inspector General for Tax Administration (TIGTA) released Fiscal Year 2023 Federal Information Security Modernization Act Evaluation. In this assessment it was concluded that “The IRS needs to take further steps to improve its security program deficiencies and fully implement all security program components in compliance with Federal Information Systems Management Act (FISMA) requirements; otherwise, taxpayer data could be vulnerable to inappropriate and undetected use,

modification, or disclosure” (FY 2023 IRS Federal Information Security Modernization Act Evaluation, 2023).

The IRS Cybersecurity Program was not considered fully effective due to program components that were not at an acceptable maturity level. TIGTA rated three Cybersecurity Framework function areas as “not-effective” and two as “effective.”

“The IDENTIFY, PROTECT, and DETECT capabilities are “not effective” and the



RESPOND and RECOVER capabilities are “effective” based on a Managed and Measurable – Level 4 rating” (FY 2023 IRS Federal Information Security Modernization Act Evaluation, 2023).

Examples of functional areas that were defined by TIGTA as not-effective include ability to keep an accurate record of its information systems, track and report on current hardware and software assets, maintain information systems in line with IRS policy, secure data at rest through encryption and establish multi-factor authentication across its facilities and network.

In Fiscal Year 2023, the Inspector General FISMA reporting followed the guidelines of the

National Institute of Standards and Technology’s (NIST) Framework for Improving Critical Infrastructure Cybersecurity and assessed the maturity level in five function areas. The five Cybersecurity Framework function areas and the associated security program components are IDENTIFY (Risk Management and Supply Chain Risk Management), PROTECT (Configuration Management, Identity and Access Management, Data Protection and Privacy, and Security Training), DETECT (Information Security Continuous Monitoring), RESPOND (Incident Response), and RECOVER (Contingency Planning).

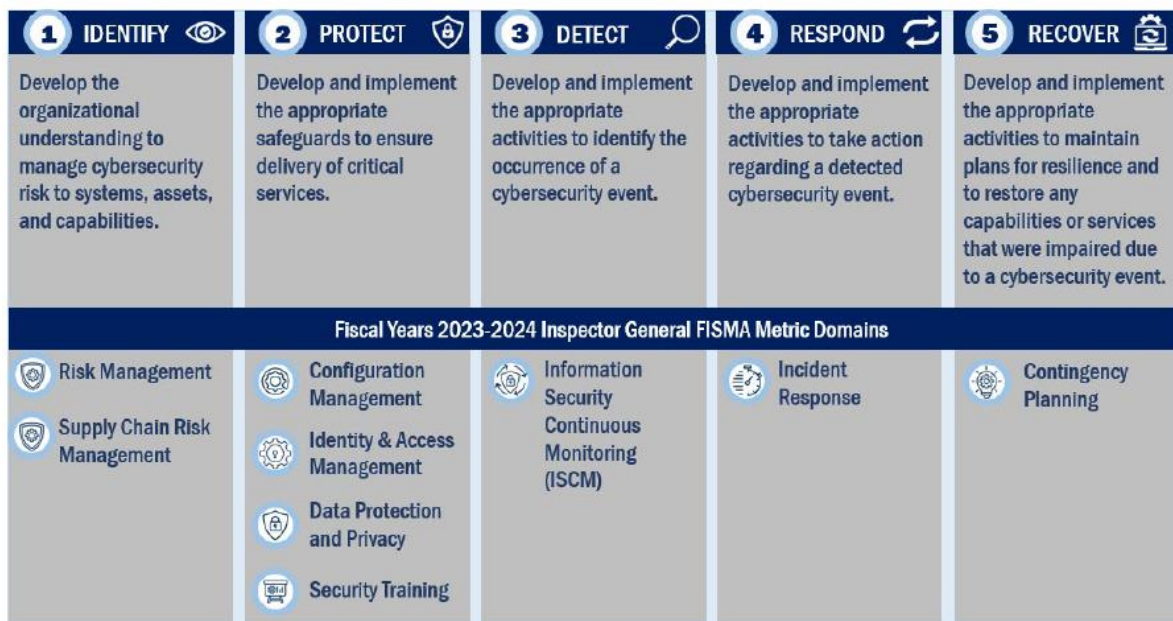


Figure 4: Alignment of NIST Cybersecurity Framework Function Areas to the Fiscal Years 2023-2024 Inspector General FISMA Metric Domains

Source: Fiscal Years 2023-2024 Inspector General FISMA Reporting Metrics and NIST Framework for Improving Critical Infrastructure Cybersecurity

This means that, despite continuous efforts, the IRS was unable to build robust and reliable IT infrastructure. Currently there are over 600 independent applications in use by the IRS, many of which are custom-built and run on-premises in IRS data centers. The integrations among these applications—when they exist—usually use custom, single-use code to share data only between two applications, also known as point-to-point integrations. Because many of these applications were developed in different computing eras over the past 20 or so years, they rely upon a specific infrastructure configuration and complex

development and deployment processes, which increase cost, risk and staff training time.

In the contemporary landscape of technological innovation, various industries have explored the potential of blockchain to revolutionize their operations and address complex challenges. However, despite its transformative promise, the IRS has not actively pursued blockchain technology as a solution to its intricate IT infrastructure issues.

The subsequent section of this research article is dedicated to the examination of the potential opportunities that blockchain technology can offer, specifically for the advancement of the IRS and, more broadly, the U.S. tax system.



Application of blockchain technology for the benefits of the U.S. tax system

Blockchain technology has emerged as a transformative force across various industries, promising enhanced security, transparency and efficiency in data management and transaction processes. Blockchain technology, originally conceptualized as the foundation for cryptocurrencies, has evolved to encompass a broader spectrum of applications. Its unique features have led to its adoption in finance, supply chain management, healthcare and beyond.

Broadly speaking, “blockchain is a type of distributed, digital ledger or database that is shared across a network and aggregates transactions into chains or blocks” (Mazur, 2022).

Blockchain technology's distinct features of decentralization, immutability, consensus mechanisms and smart contracts collectively contribute to its transformative potential across diverse sectors.

At the heart of blockchain lies its decentralized nature. Unlike traditional centralized systems, where a single entity exercises control, blockchain operates on a distributed network of nodes. Each participant holds a copy of the entire ledger, ensuring that no single entity has complete authority. This decentralized structure enhances security and resilience by eliminating single points of failure.

Blockchain's immutability resulted from its utilization of cryptographic hashing. Once data is added to a block and added to the chain, the updated ledger is synchronized across all the nodes in the network. Altering it would require changing every subsequent block, rendering manipulation practically impossible. This feature assures the integrity and authenticity of recorded information, instilling trust among participants.

Consensus mechanisms play a pivotal role in blockchain's functionality. These protocols ensure that all participants within the network agree on the validity of transactions before they are added to the chain. Diverse consensus mechanisms are available to validate the data entered into the system. The choice of method is contingent upon the specific blockchain architecture and the requirements of the network. Popular mechanisms include Proof of Work (PoW) and Proof of Stake (PoS), each with its unique advantages and trade-offs. PoS consensus mechanism is based on the principle that the validators have invested resources into the network. PoW consensus mechanism, on the contrary, is designed to make sure that there is a

verifiable ledger of all previous transactions. Consensus mechanisms contribute to the security and efficiency of blockchain networks.

Smart contracts are self-executing contracts with predefined rules and conditions encoded directly into the blockchain. They enable automated and trustless execution of agreements, eliminating intermediaries and streamlining processes. Smart contracts expand the scope of blockchain applications beyond transactions to include complex business logic and automation.

Blockchain network can be designed in various manners, tailored to meet the goals and operational necessities of specific blockchain systems. There are primarily three types of blockchain systems based on their level of decentralization:

Public blockchain is fully open to the public, allowing anyone to participate, validate transactions, and create new blocks. It operates in a decentralized manner where there is no single owner or intermediary holding control. Examples include Bitcoin and Ethereum.

In contrast, a private blockchain is restricted to a specific group of participants. Permission is required to access and validate transactions. So, this type of blockchain does not possess “classic” blockchain's features like decentralization and permissionless. Instead, the owners of the blockchain invite, authorize and limit who may participate in the network and designate the user's rights to view, add and validate transactions on the ledger. This type of blockchain is commonly used within organizations to maintain control over participants and data.

Consortium blockchains are a hybrid between public and private blockchains. They are controlled by a pre-selected group of entities or organizations rather than a single entity, offering a balance between decentralization and control. Consortium blockchain are designed as semi-decentralized structures where multiple parties (either private or public) participate in implementing, upholding and validating blockchain transactions on the platform.

These categories can further be refined based on the consensus mechanism used, governance models and additional features tailored to specific use cases.

The U.S. tax system can significantly benefit from application of blockchain technology. The most compelling advantages for tax administration offered by blockchain technology encompass the establishment of trust in processes, heightened



transparency, the potential for operational streamlining and other benefits (Mazur, 2022).

Trust and Accountability: Due to its ability to verify transactions and uphold their ongoing integrity, blockchain offers a mechanism for generating "trusted audit trails" of dependable information, which all parties involved can rely upon, in case the data source is reliable (Lyons et al., 2018). Trust is crucial for successful tax administration. Tax authorities need to have trust in the information provided by taxpayers, while taxpayers need to have trust in the fairness of the national tax system. With its transaction verification and sustained integrity upkeep, blockchain offers a way to generate "trusted audit trails" of dependable information which can be relied on by all relevant parties.

Transparency and Traceability: Transparency is another feature inherent to blockchain technology that can yield substantial benefits for the U.S. tax system. By its very nature, blockchain creates an unalterable and transparent record of transactions. This transparency can enhance tax compliance and reduce fraudulent activities by providing a clear, traceable and accessible history of financial transactions. Tax authorities can have real-time visibility into financial activities, enabling quicker and more accurate assessments. Furthermore, the transparency of blockchain can foster trustworthiness within the U.S. tax system. The immutability of recorded information ensures that no single party can manipulate or falsify records. This can mitigate disputes and enhance accountability within the tax ecosystem.

Immutability and Data Security: Blockchain's cryptographic security ensures that sensitive taxpayer data is well-protected against unauthorized access and tampering. Taxpayers can have greater confidence that their private financial information is secure. The immutability of blockchain records makes it exceedingly difficult to alter or falsify financial data. This reduces the risk of fraudulent activities, enhancing the overall integrity of the tax system.

Smart Contracts and Cost Efficiency: U.S. tax system is very complex, and tax rules undergo frequent revisions due to constant changes in the underlying legislation. Currently, tax software developers face the challenge of individually updating system algorithms in their products at least on an annual basis, a process that proves to be inefficient. Automating processes through blockchain can significantly reduce administrative costs for all parties involved. Utilizing smart contracts on the blockchain can automate tax

calculations and payments for the whole network. This automation ensures accuracy, reduces manual errors, and streamlines the tax process for both taxpayers and tax authorities. Smart contracts can enforce tax obligations automatically, minimizing administrative burdens.

Real-time Tracking and Audit Efficiency: The complexity of the U.S. tax system, coupled with the dynamic nature of tax regulations, necessitates a responsive approach to tax administration. Unlike traditional systems, where transaction data might take time to be processed and relayed, blockchain offers the advantage of instant updates and tracking. Blockchain's real-time tracking capability would allow tax authorities to monitor financial transactions in real-time. This feature enables quicker identification of discrepancies and reduces the time and effort required for audits. Blockchain's permanent and transparent ledger eliminates the need for lengthy and resource-intensive manual audits. Auditors can access a reliable, up-to-date record of transactions, speeding up the auditing process.

Interoperability: Blockchain interoperability refers to the capability of different blockchain networks or platforms to seamlessly communicate, share data and collaborate with each other. In essence, it allows distinct blockchain systems to interact and exchange information in a secure and transparent manner, even if they are built on different protocols or have separate functionalities. Interoperability is essential for realizing the full potential of blockchain technology, especially in scenarios where multiple parties, organizations or systems need to work together. Blockchain interoperability creates enormous potential for U.S. tax administration, which is currently experiencing significant difficulties with managing its numerous independent applications. Integrating blockchain technology into the tax system establishes a framework where information can be securely exchanged, and transactions can be validated across diverse applications. This fosters a more interconnected and adaptable tax ecosystem.

Tokenization Potential: Tokenization, within the context of blockchain technology, commonly refers to the procedure of transforming the entitlements to an asset into a digital representation of that asset. Tokenization can offer substantial benefits to the tax system by revolutionizing the way assets are represented, tracked and managed. Currency tokens serve as a prime illustration of tokenization that holds notable potential for enhancing tax administration functionalities. These tokens typically promote streamlined and transparent



transactions between parties. Moreover, if the currency token or coin employed for transactions is government-issued and blockchain-based, it can potentially augment transaction visibility. This could equip tax authorities with real-time, accurate transactional data, resulting in a more dependable audit trail. Overall, tokenized fiat currencies have the potential to enable governments to eventually realize the automation of payments in real time through the utilization of smart contracts, marking a notable stride forward (Lyons et al., 2018). Besides that, tokenization enables the division of various assets into smaller, tradable units (tokens). In the tax system, this can allow for fractional ownership of assets, making it easier for taxpayers to manage and transfer ownership of assets. This can have implications for capital gains and losses, as well as inheritance taxes. Tokenization can also facilitate cross-border transactions by providing a standardized representation of assets. This can streamline tax reporting and compliance for international transactions.

According to the author's perspective, a suitable blockchain network for U.S. tax administration purposes would ideally adopt a private (permissioned) or consortium blockchain structure. Individual taxpayers' access should be limited solely to their personal tax data, with the tax authorities (organizing party) being responsible for assigning permission rights to taxpayers' accounts (nodes).

As blockchain was initially introduced as a means to eliminate the involvement of third parties and controlling entities, such as banks and governments, from specific transactions, the concept of employing private (permissioned) blockchains involving tax authorities as organizers and controllers, might appear counterintuitive at first glance, as it creates concerns regarding trust. However, this trust issue can find resolution through the application of an algorithmic function called zero-knowledge proof. Zero-knowledge proof is a cryptographic concept that allows one party (the prover) to demonstrate the validity of a statement to another party (the verifier) without revealing any specific details about the statement itself. In other words, it enables a party to prove that they possess certain information or knowledge without disclosing the actual content of that information (Baisalbayeva, 2019).

Vigorous discussions revolve around determining the most fitting consensus mechanism for a blockchain-driven tax system. The Proof of Work (PoW) consensus mechanism, while effective in several aspects, also comes with a set of

disadvantages. Firstly, it is associated with high operational costs due to its requirement for substantial computational power and energy to solve complex mathematical puzzles. Secondly, PoW mechanism faces challenges in maintaining transaction speed and efficiency. The Proof of Stake (PoS) consensus mechanism, although considered more energy efficient, tends to favor participants with larger stakes, potentially leading to centralization of power and decision-making, which is fundamentally unsuitable for the requirements of a blockchain-based tax system. The Proof of Authority (PoA) is a consensus mechanism which sacrifices decentralization in order to achieve high throughput and scalability. The PoA consensus algorithm leverages the value of identities. In this mechanism, block validators aren't staking coins; instead, they stake their reputation. This distinct approach secures PoA blockchains through the participation of validating nodes that are chosen based on their recognized trustworthiness. The Proof of Authority model relies on a predetermined group of block validators, which contributes to its exceptional scalability. Within this framework, blocks and transactions receive validation from pre-approved participants who effectively function as system moderators. Incorporating Proof of Authority consensus mechanism into a blockchain-based tax system seems feasible, as it can streamline processes, enhance transparency and ensure that authorized entities are responsible for maintaining the accuracy and security of tax-related data.

There is an opinion that "the full realization of a blockchain-facilitated tax regime will not happen until mandatory digital invoicing systems are entirely operational" (Yent, 2020). Digital invoicing, also known as e-invoicing or electronic invoicing, refers to the process of creating, sending, receiving, and processing invoices in digital format instead of traditional paper documents. For more transformative advantages, digital invoicing should be organized on the blockchain, which will enable creation of a secure, transparent and tamper-proof ecosystem. With digital invoicing all the transactions will be automatically recorded and verified at the moment they are executed, thus giving tax authorities an opportunity to monitor transactions in real time. This will significantly enhance the effectiveness of the tax administration, as no additional reconciliation and subsequent auditing would be required.

It's important to highlight that although blockchain technology facilitates transaction validation, it does not possess the capability to



authenticate external, non-intrinsic data underlying the transactions. This is where digitalized currency can be of great benefit. In order to increase transparency of the transactional cash flows and ensure accuracy and completeness of taxpayers' income reporting, it would be prudent for the government to contemplate the adoption of a tokenized currency within a blockchain framework. Utilizing a blockchain-based medium of exchange would notably enhance traceability of payments, moreover, this approach would introduce a standardized data format that could seamlessly integrate onto taxpayers' online, blockchain-based ledgers. This integration has the potential to automate the accumulation, aggregation, storage and analysis of a broader spectrum of transactional data for taxpayers (Mazur, 2022).

Identity management is another crucial aspect of the blockchain-based tax system. To fully leverage the advantages of blockchain, the government should prioritize the establishment of a digital identification system. A digital ID system has a potential to revolutionize tax administration and other government functions. At this point the absence of a dependable, unified digital identity system poses a notable obstacle to the integration of blockchain systems for government purposes (Third, 2018). Incorporating a unified digital identity system into the US tax framework has the potential to drive efficiency, accuracy and security, ultimately leading to a more effective and responsive tax administration system.

A significant portion of the professional community advocating for the digitalization of the tax system holds the consensus that the integration of blockchain should be introduced progressively, implemented in distinct stages. Value added tax (VAT) is commonly seen as a starting point for blockchain application for the tax purposes in the jurisdictions utilizing the VAT system (Yent, 2020; Ainsworth et al., 2017).

For the U.S. tax system blockchain-based platform can initially be implemented "to aggregate, store, and securely share required information returns" (Mazur, 2022). The current system of informational reporting, where agents submit returns to both the IRS and taxpayers separately, is notably lacking in effectiveness. A solution based on blockchain technology has the potential to offer substantial benefits to informational reporting by streamlining processes, reducing friction, and optimizing the costs associated with compliance.

II. Conclusion

Historically the U.S. tax administration has encountered significant challenges in effectively managing its extensive IT infrastructure. The U.S. tax system is characterized by remarkable complexity exacerbated by the dynamic nature of tax regulations which undergo frequent updates and substantial changes that occur at least on an annual basis. The IRS consistently struggled to identify a comprehensive solution to effectively address the entire problem and chose to adopt a stopgap approach, constantly implementing interim measures and partial solutions. This strategy has ultimately resulted in the current state, where there are more than 600 separate and non-integrated applications in use by the IRS which were developed over the past two decades.

The cornerstone of the U.S. tax system rests upon the principle of voluntary compliance, which entails the IRS relying on taxpayers to accurately determine their tax liability, correctly file their returns and promptly remit the owed taxes. However, overall complexity of the national tax regulations frequently presents an invincible barrier to achieving voluntary compliance. While some taxpayers experience difficulties with correct treatment of the tax rules, others are capable of exploiting ambiguities within the legislation to their advantage. Simultaneously, the IRS faces its own challenges in addressing existing issues with underreporting, non-filing and underpayment due to its outdated IT infrastructure and a shortage of resources – both in terms of personnel and finances.

The application of blockchain technology offers a transformative opportunity for the U.S. tax system. By addressing existing challenges such as tricky compliance rules, lack of transparency and outdated infrastructure, blockchain can usher in a new era of efficiency, accuracy and trust. Through its inherent characteristics of transparency, immutability and enhanced security, blockchain has the capacity to streamline transaction reporting, facilitate real-time tracking and bolster data integrity. This, in turn, can foster a higher degree of voluntary compliance, reduce the tax gap and empower tax authorities to uphold a fair tax framework. Furthermore, the potential incorporation of tokenized currency, digital invoicing and a unified digital identity system further amplifies the benefits that blockchain can bring to the tax administration. As the U.S. tax system continues to evolve in the digital age, embracing blockchain technology could serve as a pivotal step towards a more efficient, accountable and equitable tax ecosystem.



Abbreviations:

ADP – Automated Data Processing
BSM – Business Systems Modernization
CADE – Customer Account Data Engine
CIO – Chief Information Officer
FATCA – Foreign Account Tax Compliance Act
FISMA – Federal Information Systems Management Act
GAO – Government Accountability Office
IMF – Individual Master File
IRA – Inflation Reduction Act
IRC – Internal Revenue Code
IRS – Internal Revenue Service
NCR – Net compliance rate
NIST – National Institute of Standards and Technology
NMP – Net misreported percentage
PoA – Proof of Authority
PoS – Proof of Stake
PoW – Proof of Work
RRA – Restructuring and Reform Act
RAAS – Research, Applied Analytics and Statistics Division
TAS – Tax Administration System
TIGTA – Treasury Inspector General for Tax Administration
TSM – Tax System Modernization
VAT – value added tax
VCR – Voluntary compliance rate
VRR – Voluntary reporting rate

Acknowledgement

All authors have read and agreed to the published version of the manuscript.

Author Contributions: Conceptualization, methodology, validation, formal analysis, investigation, resources, writing, review and editing, by the corresponding author.

Funding: This research was funded by the corresponding author.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

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